

in geodesy, where he extended Legendre's theorems on the treatment of large spherical triangles; in celestial dynamics; and especially in the theory of precise celestial photography, to which he contributed formulæ of great generality, and at the same time great convenience.

The untimely death of M. Trépied is one of the heaviest of the great misfortunes which have robbed France within the last few years of nearly all the men who bore so distinguished a part in the inception and development of the great enterprises in which French astronomy has been involved.

He was elected an Associate of the Society 1901 November 8.

A. R. H.

HERMANN CARL VOGEL, the announcement of whose death on August 13, 1907, was everywhere received with profound regret, will always occupy a high place in the history of astronomy as one of the pioneers in the new fields of inquiry opened up by the application of the spectroscope to the study of the heavenly bodies. He was born at Leipzig on April 3, 1841, and, while yet a student at the university, was appointed as assistant at the observatory in that city in 1865. During the preceding three years a great impetus was given to spectroscopic astronomy by the striking results which had been obtained by Rutherford in America, Secchi in Italy, and Huggins in England, and there can be little doubt that at this time Vogel was especially attracted by the great possibilities which the work of these observers suggested. He was probably still further influenced at a little later stage by the discovery of the method of observing solar prominences without an eclipse which was made by Lockyer and Janssen in 1868, and by the first researches of Huggins on the movements of stars in the line-of-sight. At all events, after taking his degree in 1867, we find him to have been actively engaged with Zöllner in 1869 in the observation of solar prominences, and from this time to his death his energies were chiefly directed along astrophysical lines of research.

The record of Vogel's work at the private observatory founded by von Bülow at Bothkamp, of which he was in charge from 1870 to 1874, is the best possible testimony to his great skill and industry in the earlier part of his career. From the well-known publications of the observatory during this period we see that his outlook was already a wide one; the spectra of the Aurora, the Zodiacal Light, and lightning received his careful attention, no less than those of the Sun, stars, star clusters, nebulæ, comets, and planets. For these observations he employed a spectroscope which he had specially designed to secure the stability which is essential to useful work on the motions of the stars, and for the determination of wave-lengths with reasonable accuracy. The results of some of these observations have naturally been superseded by others which have since been made with more powerful instruments, but they were of the highest order for the period, and Vogel was himself always among the first to devise and employ improved methods of observation.

Among the more notable of Vogel's achievements at Bothkamp were the spectroscopic determination of the Sun's rotation, and his classical work on the spectra of planets. Employing a "reversion spectroscope" of the form designed by Zöllner, he indeed obtained the first spectroscopic proof of the Sun's rotation by the opposite displacements of the solar lines at the east and west limbs, and at the same time established the truth of the Doppler principle on which the determination of velocities is based.

The successful work at Bothkamp, in conjunction with that of Spörer, was chiefly instrumental in securing the foundation by the Prussian Government of the present Astrophysical Observatory at Potsdam, the erection of which was commenced in 1874. Vogel was immediately appointed as an observer, and, in 1882, on the observatory passing from the control of the commission at first in charge of the work, he was promoted to the responsible post of Director. It is generally acknowledged that his administration of this important observatory, intended for the advancement of what was practically a new science, and bound by no traditions, has been completely successful in establishing and maintaining a high standard of accuracy in all its numerous undertakings.

Vogel early recognised the importance of preparing a spectroscopic catalogue of the stars on a more extensive scale than had been previously attempted, and, with the assistance of Dr. Müller, in the years 1880 to 1882, he catalogued the spectra of all the stars down to magnitude 7·5 in the zone  $-1^{\circ}$  to  $+20^{\circ}$ , the total number amounting to 4051. The classification adopted was that proposed by Vogel in 1874, being an extension of Secchi's system, and definitely introducing Zöllner's idea that the different spectra exhibited by the stars depend upon the temperatures which they have reached in a general evolutionary process. In 1895 this classification was further extended so as to take account of the additional features revealed by photographic spectra; and though not universally adopted in detail, its leading principle is embodied in other classifications which have been put forward.

No material advance in the investigation of stellar motions was made until the introduction of the photographic method by Vogel at Potsdam in 1887. The various sources of error which were liable to influence the minute displacements of the lines were thoroughly investigated, and during the next three years the labours of Vogel and Scheiner set this department of astrophysics on a firm foundation. The results were consistent and accurate to an unexpected degree, as was shown by the agreement between the displacements found in the spectra of the Sun and Venus with those resulting from direct calculation. The velocities of 51 stars thus determined were published in 1892 (see *M.N.*, vol. lii. pp. 87 and 541), and an important deduction was that the average line-of-sight velocity — 16·5 kilometres per second — was much smaller than had been previously supposed.

Two results of special interest followed from the spectrographic work during this period, namely, the well-known con-

firmation of Goodricke's explanation of the variability of *Algol* by periodic eclipses produced by a revolving dark companion, and the discovery that *Spica* is a similar system in which the plane of revolution does not pass through the Sun. The interesting facts relating to the dimensions and masses of these systems have passed into the general literature of astronomy and need no further comment, except to recall that, according to Campbell, no less than one in seven of the stars which have been sufficiently observed have since been found to be similarly accompanied by relatively dark bodies. The provision for such investigations at Potsdam was greatly augmented in 1899 by the erection of a telescope of  $31\frac{1}{2}$ -inches aperture; and though Vogel's health failed in the year following, the work has been energetically carried on with marked success.

Dr. Vogel's name is associated with other pieces of work of great magnitude which have been carried out at Potsdam under his superintendence. He took an important part in the initiation of the International Chart of the Heavens in 1887, and undertook the zone  $+31^{\circ}$  to  $+40^{\circ}$  as the Potsdam contribution to this great work. He did not live to see the completion of this task, but all the necessary photographs have been secured and four volumes of results have been published.

Another notable undertaking at Potsdam was the precise photometric determination of the brightnesses of all the stars not recorded as fainter than magnitude 7.5 in Argelander's *Durchmusterung*. In the capable hands of Doctors Müller and Kempf this has been brought to a successful conclusion, and is characterised throughout by the extreme care which has been taken to secure the greatest possible accuracy. The General Catalogue, issued in 1907, refers to no less than 14,199 stars.

Dr. Vogel also made valuable contributions to our knowledge by his careful studies of "New Stars," and by his investigations of the absorption of the solar atmosphere for light of different wavelengths. Mention may also be made of an important series of observations of the positions of nebulae and clusters which he made at Leipzig, with a special view to their future use in the investigation of possible changes.

No less than nineteen learned societies in various parts of the world showed their appreciation of Dr. Vogel's services to science by electing him as honorary member, and, in addition, he was awarded the Gold Medal of the Danish Academy in 1874, the Valz Prize of the Paris Academy in 1891, the Henry Draper Gold Medal of the U.S. National Academy of Sciences in 1892, the Gold Medal of the Royal Astronomical Society in 1893, and the Bruce Gold Medal of the Astronomical Society of the Pacific in 1905. In 1895 he received the honour of the Prussian Order of Merit, and was nominated Privy Councillor of Germany four years later.

This brief notice of a great career cannot be more fittingly closed than by quoting some of the concluding remarks made by Mr. Knobel on the presentation of the Society's Gold Medal to Dr.

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Vogel in 1893: "It is a record of unwearying perseverance to accomplish great work; moreover it is the chronicle of a masterly attainment of success. . . . Not only is astronomy enriched by a series of investigations of the greatest value, but a distinct, and indeed marvellous, advance is made in our knowledge and conception of the stellar universe."

He was elected an Associate of the Society 1882 November 10.

A. F.